Arthur D. Little Flexible Fuel Processor Program Overview

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Introduction

Since 1991, Arthur D. Little (ADL) has been pursuing partial oxidation (POX) technology for use in transportation fuel cell systems (1,2). As reformer component-based testing nears its completion, ADL is preparing to perform system tests using our patented reformer technology in conjunction with a Los Alamos National Laboratory (LANL) preferential oxidizer (PROX) and a proton exchange membrane (PEM) fuel cell. This paper will discuss the state of development of the ADL multi-fuel reformer, various methods for CO clean-up currently under investigation, compressor/expander technology, and the necessary steps to integrate and test a complete fuel cell power system using gasoline and ethanol as primary fuels.

Figure 1 details the components of a catalytic POX reactor system. The required heats of reaction for the entire reforming process are supplied in-situ by oxidizing a fraction of the feedstock in the combustion zone. The extent of the oxidation reaction is regulated by the quantity of oxygen addition. Without the benefit of the catalyst clean-up bed after the combustion zone, the POX process needs to operate at higher temperatures (1100- 1500 °C) than the catalyst-assisted reforming processes which operates in a temperature range between 800- 1000 °C. The separation of the POX and catalyst zones provides a pure gas-phase front end to the reformer, allowing for multi-fuel operation.

The process effluent from the partial oxidation reactor consists of hydrogen, residual methane, water vapor, carbon dioxide, nitrogen, and carbon monoxide which requires the two-stage water-shift reaction and additional CO removal, similar to that in the steam reforming process. The carbon monoxide is converted in the shift reactors to an exit concentration of less than 1%.

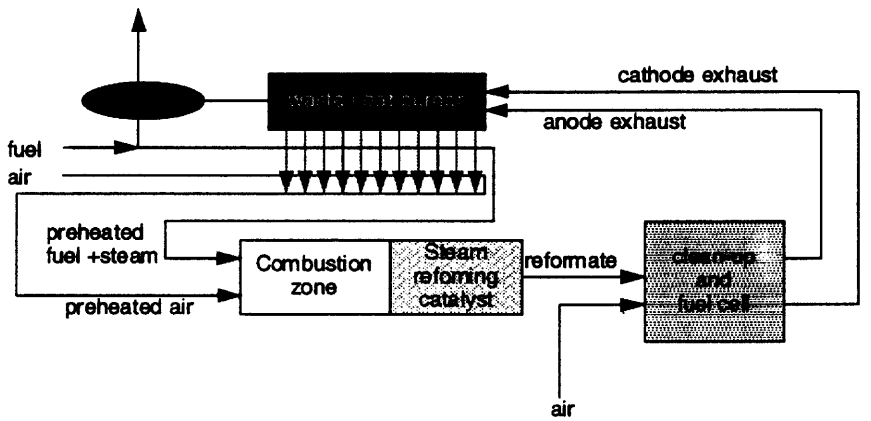

Figure 1. Catalytic POX Reactor System

Multi-fuel Reformer Development

Ethanol and Hydrated Ethanol Reformer: Ethanol and hydrated ethanol blends were examined over the course of the past year to determine the feasibility for the use of ethanol as a transportation fuel for fuel cell vehicles. Furthermore, the effects of different levels of hydration were considered as the use of hydrated ethanol may allow additional cost savings during fuel production. The test matrix for the experiments included the following variables: